Phys 131 2016

Lecture 4

Mon: HW due by 5pm

Tues: Discussion / quiz

Supp Ex 9, 11

Ch 2 Con Q 11

Ch 2 Probs 9, 12, 38

Extra challenge optional

40, 82, 41

Weds: Lecture.

Survey: Q1 Hope to learn ?

Q2 Do with knowledge ?

TYPICAL: physics content, motion, everyday world
application to major / career; get degree

ALSO: * solve problems, arguments using technical concepts / math,
* doing word problems
* decide what is relevant

Recap : Velocity

Velocity describes the rate at which position changes. Schematically:

Velocity = rate of change of position — Conceptual Idea

⇕

Mathematical Definition

Observe position, x, as time, t passes. Then

$$v = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$$

⇢ speed = absolute value of velocity

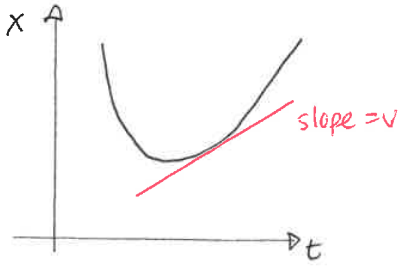
⇓ Computing / calculating

Given position information, how to get velocity

1) Use calculus to get derivatives

2) graphically

v = slope of tangent to x vs t

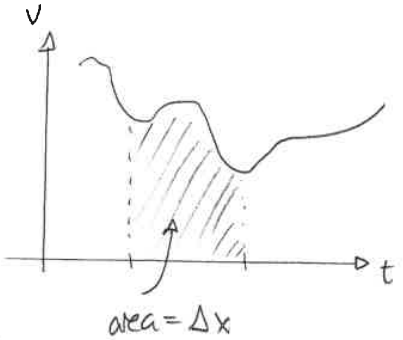


Given velocity information, how to get position

1) use calculus (integration)

2) graphically:

Δx = area between graph of v vs t at time axis



Acceleration

Although velocity contains useful information about motion, it is not the quantity that appears most readily in the physics of motion. That role belongs to quantity that describes how velocity changes. Specifically we need to consider the rate at which velocity changes - this is acceleration. Before defining this we consider ways in velocity can change as time passes.

Demo PhET Moving Man → Charts Tab

Set $\begin{cases} x_0 = 0 \\ v_0 = -4 \\ a = 2 \end{cases}$

observe - graph of x, v

- look at a) initial → left most turn
  b) moving left → moving right
  c) after turn

We see that velocity can change by either or both of:

a) speed changing
b) direction changing

To describe changes in velocity we will use:

Acceleration = rate of change of velocity with respect to time

with formal definition

time t_i — velocity v_i "initial"

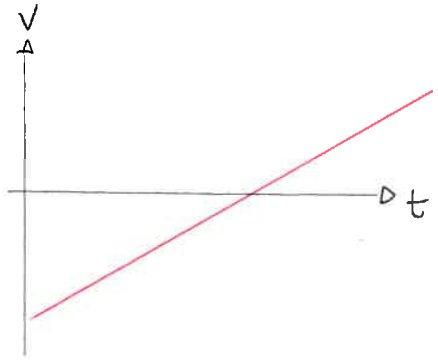
time t_f — velocity v_f "final"

The average acceleration over an interval from t_i to t_f is:

$$a_{avg} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$$

units: m/s^2

Consider the moving man demo:



time t	velocity v
0.0s	−4.0m/s
1.0s	−2.0m/s
2.0s	0.0m/s
3.0s	2.0m/s
4.0s	4.0m/s

graph ⇒ velocity increases at a constant rate.

data ⇒ velocity increases by 2.0m/s every 1.0s.

⇒ acceleration = $\frac{2.0\text{m/s}}{1.0\text{s}} = 2.0\text{m/s}^2$

Warm Up 1

Note: 1) acceleration describes how velocity changes with time and does not give complete information about velocity at any single instant.

Quiz1

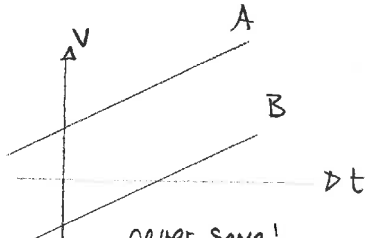
There is no direct correlation between larger velocity and larger acceleration. The moving man demo illustrates this. The acceleration is the same but the velocity is constantly changing.

2) Acceleration is not immediately related to speed. We can see that at 1.0s and 3.0s the speeds of the man are the same. But his acceleration is non-zero.

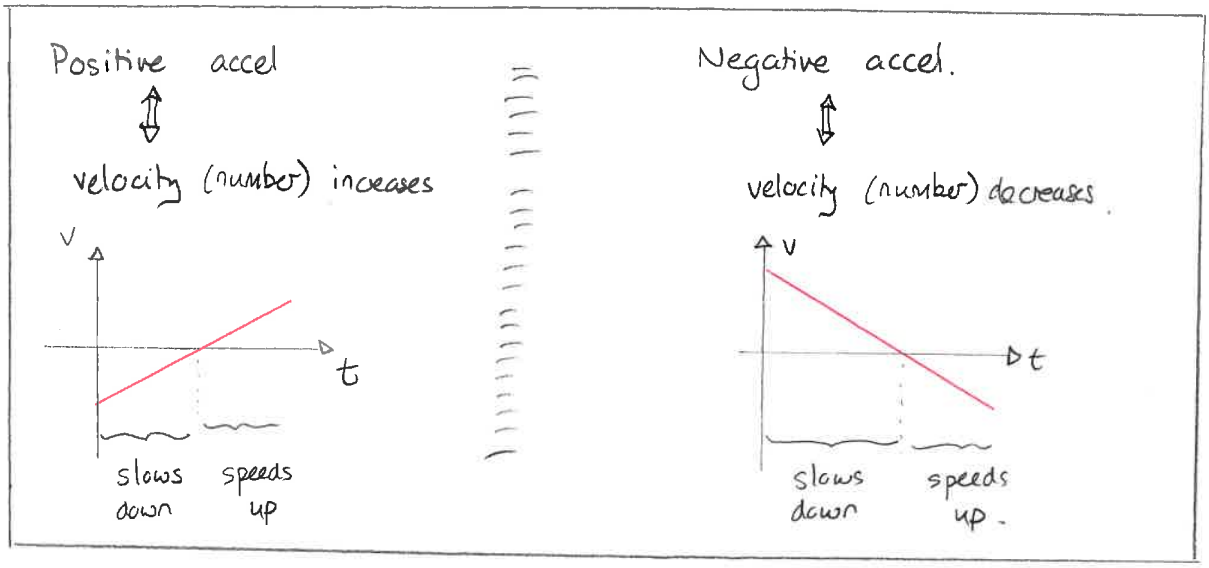
Warm Up2

Demo: Moving Man:

A) $v = 4\text{m/s}$, $a = 2\text{m/s}^2$ vs B) $v = -4\text{m/s}$, $a = 2\text{m/s}$



Additionally acceleration can be positive or negative. The sign of acceleration only describes how velocity changes.



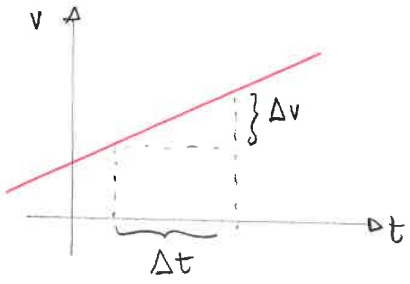
Quiz 2

Quiz 3

Demo. Moving Man demo

Motion with constant acceleration

Most of these examples have illustrated motion with constant acceleration. In these cases a graph of velocity vs time gives a straight line and



Acceleration = slope of velocity vs time graph

Additionally, it is exactly true that $a = \frac{\Delta v}{\Delta t}$

Thus

$$\Delta v = a \Delta t$$

$$\Rightarrow \boxed{V_f = V_i + a \Delta t}$$

Constant acceleration only